**AKSHAYA INSTITUTE OF TECHNOLOGY,TUMKUR**
Department of Electronics & Communication Engineering

Module 1 Notes for

# “Multimedia Communication”

# [BCE613A]

## Prepared by:

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# AKSHAYA INSTITUTE OF TECHNOLOGY

Lingapura, Obalapura Post, Koratagere Road, Tumakuru - 572106

## DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

## VISION

To produce competent engineering professionals in the field of Electronics and Communication Engineering by imparting value based quality technical education to meet the societal needs and to develop socially responsible citizens.

## MISSION

**M1:** To provide strong fundamentals and technical skills in the field of Electronics and Communication Engineering through effective teaching learning process.

**M2:** Enhancing employability of the students by providing skills in the fields of VLSI, Embedded systems, Signal processing, etc., through Centre of Excellence.

**M3:** Encourage the students to participate in co-curricular and extra-curricular activities that creates a spirit of social responsibility and leadership qualities.

EST 2009
AKSHAYA
TUMKUR

## Program Specific Outcomes (PSOs)

***After Successful Completion of Electronics and Communication Engineering Program Students will be able to***

1. Apply fundamental knowledge of core. Electronics and Communication Engineering in the analysis, design and development of Electronics Systems as well as to interpret and synthesize experimental data leading to valid conclusions.
2. Exhibit the skills gathered to analyze, design, develop software applications and hardware products in the field of embedded systems and allied areas.

## Program Educational Objectives (PEOs)

**PEO1:** Graduates exhibit their innovative ideas and management skills to meet the day to day technical challenges.

**PEO2:** Graduates utilize their knowledge and skills for the development of optimal solutions to the problems in the field of Electronics and Communication Engineering..

**PEO3:** Graduates exhibit good interpersonal skills, leadership qualities and adapt themselves for life-long Learning

| | Multimedia Communication | | Semester | 6 |
|---|---|---|---|---|
| | CourseCode | **BCE613A** | CIEMarks | 50 |
| | TeachingHours/Week(L:T:P:S) | 3:0:0 | SEEMarks | 50 |
| | TotalHoursofPedagogy | 40 | TotalMarks | 100 |
| | Credits | 03 | ExamHours | |
| | Examinationtype(SEE) | Theory | | |

**Courseobjectives:**

- Gainfundamentalknowledgeinunderstandingthebasicsofdifferentmultimedia Networks and applications.
- Understanddigitizationprincipletechniquesrequiredtoanalyzedifferentmedia Types.
- Analyzecompressiontechniquesrequiredtocompresstextandimageandgain Knowledge of DMS.
- Analyzecompressiontechniquesrequiredtocompressaudioandvideo.
- Gainfundamentalknowledgeaboutmultimediacommunicationacrossdifferent Networks.

**Teaching-LearningProcess(GeneralInstructions)**

ThesearesampleStrategies,whichteacherscanusetoacceleratetheattainmentofthevariouscourseoutcomes.

1. Lecturemethod(L)doesnotmeanonlythetraditionallecturemethod,butadifferenttypeofteachin gmethodmaybeadoptedtodeveloptheoutcomes.
2. ShowVideo/animationfilmstoexplainthefunctioningofvarioustechniques.
3. Encouragecollaborative(Group)Learningintheclass.
4. AskatleastthreeHOTS(Higher-orderThinking)questionsintheclass,whichpromotescriticalthinking
5. Topicswillbeintroducedinmultiplerepresentations.
6. Discusshoweveryconceptcanbeappliedtotherealworld-andwhenthat'spossible,ithelpsimprove the students' understanding.

**Module-1**

**MultimediaCommunications:Introduction**,Multimediainformationrepresentation,Multimedianetworks,multimediaapplications,Applicationandnetworkingterminology. (Chapter1ofText1)

**Module-2**

**InformationRepresentation**:Introduction,Digitizationprinciples,Text,Images,AudioandVideo.(Chapter 2ofText1

**Module-3**

**TextandImageCompression**:Introduction,Compressionprinciples,textcompression,imageCompression. (Chapter 3 of Text 1 )

**Module-4**

**Audioandvideocompression**:Introduction,Audiocompression,videocompression,videocompression principles, video compression. (Chapter 4 of Text 1)

**Module-5**

**MultimediaInformationNetworks**: Introduction, LANs, Ethernet, Token ring, Bridges, FDDI (Chapter 8.1 to8.6of Text 1).

**Courseoutcome(CourseSkillSet)**

Attheendofthecourse,thestudentwillbeableto:

1. UnderstandthebasicsofmultimediaCommunicationandapplications
2. Analyzemediatypestorepresentthemindigitalform.
3. Applythecompressiontechniquesontext,images,audioandvideo.
4. Understandmultimediainformationnetworks.

**AssessmentDetails(bothCIEandSEE)**

TheweightageofContinuousInternalEvaluation(CIE)is50%andforSemesterEndExam(SEE)is50%.Th eminimumpassingmarkfortheCIEis40%ofthemaximummarks(20marksoutof50)andfortheSEEmini mumpassingmarkis35%ofthemaximummarks(18outof50marks).Astudentshallbedeemedtohavesat isfiedtheacademicrequirementsandearnedthecreditsallottedtoeachsubject/courseifthestudentsecur esaminimumof40%(40marksoutof100)inthesumtotaloftheCIE(ContinuousInternalEvaluation)and SEE(SemesterEndExamination)takentogether.

**ContinuousInternalEvaluation:**

- FortheAssignmentcomponentoftheCIE,thereare25marksandfortheInternalAssessmentTestco mponent,thereare25marks.
- Thefirsttestwillbeadministeredafter40-50%ofthesyllabushasbeencovered,andthesecondtestwillbeadministeredafter85-90%ofthesyllabushasbeencovered
- Anytwoassignmentmethodsmentionedinthe22OB2.4,ifanassignmentisproject-basedthenonlyoneassignmentforthecourseshallbeplanned.Theteachershouldnotconducttwoa ssignmentsattheendofthesemesteriftwoassignmentsareplanned.
- Forthecourse,CIEmarkswillbebasedonascaled-downsumoftwotestsandothermethodsofassessment.

**InternalAssessmentTestquestionpaperisdesignedtoattainthedifferentlevelsofBloom'staxonomyasperth eoutcomedefinedforthecourse.**

**Semester-EndExamination:**

TheorySEEwillbeconductedbyUniversityasperthescheduledtimetable,withcommonquestionpapersforthecourse (**duration03hours).**

1. Thequestionpaperwillhavetenquestions.Eachquestionissetfor20marks.
2. Therewillbe2questionsfromeachmodule.Eachofthetwoquestionsunderamodule(withamaximumof3sub-questions),**shouldhaveamixoftopics**underthatmodule.
3. Thestudentshavetoanswer5fullquestions,selectingonefullquestionfromeachmodule.
4. Marksscoredshallbeproportionallyreducedto50marks

**SuggestedLearningResources:**

**Textbooks:**

MultimediaCommunications–FredHalsall,PearsonEducation,2001,ISBN-978813170994

**ReferenceBooks:**

1. Multimedia:Computing,CommunicationsandApplications-RaifSteinmetz,KlaraNahrstedt,Pearson Education, 2002, ISBN-978817758
2. FundamentalsofMultimedia–Ze-NianLi,MarkSDrew,andJiangchuanLiu.

**WeblinksandVideoLectures(e-Resources):**

- Implementationofcompressionalgorithmsusing MATLAB/anyopensourcetools(Python,Scilab,etc.)

**ActivityBasedLearning(SuggestedActivitiesinClass)/PracticalBasedlearning**

- https://www.slideshare.net
  NPTELVideoLectures
- https://archive.nptel.ac.in/courses/117/105/117105083/
- MultimediaComputinglecture:Communications&Networking–YouTube

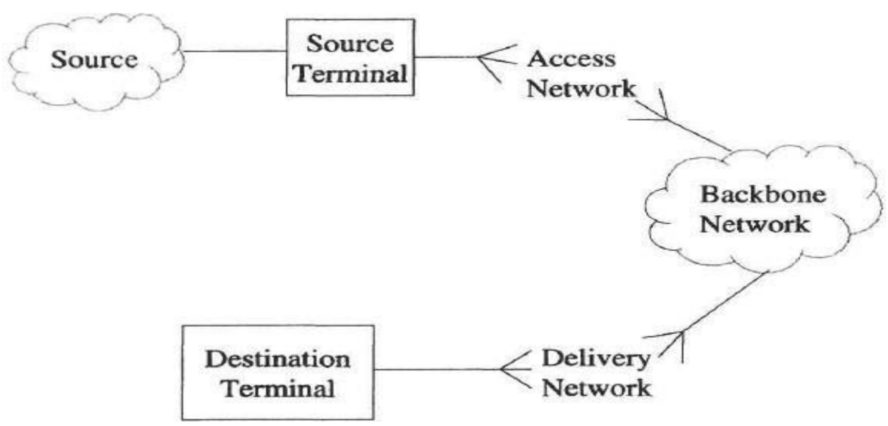
## Module1: Multimedia Communications

Multimedia communications have emerged as a major research and development area. In particular, computers in multimedia open a wide range of possibilities by combining different types of digital media such as text, graphics, audio, and video.The emergence of the World Wide Web (WWW), twodecadesago, has fuelled the growth of multimedia computing.

Multimedia – an interactive presentation of speech, audio, video, graphics, and text, has become a major theme in today‘s information technology that merges the practices of communications, computing, and information processing into an interdisciplinary field. In recent years, there has been a tremendous amount of activity in the area of multimedia communications: applications, middleware, and networking. A variety of techniques from various disciplines such as image and video processing, computer vision, audio and speech processing, statistical pattern recognition, learning theory, and data-based research have been employed.

Inthischapter,weareinterestedinmultimediacommunications;thatis,we are interested in the transmission of multimedia information over networks. By *multimedia,* we mean data, voice, graphics, still images, audio, andvideo, and werequire that the networks supportthe transmission of multiple media, often at thesame time.

Fig1.1: componentsofmultimediacommunicationnetwork



In Figure 1.1 the Source consists of any one or more of the multimedia sources, and the job of the Source Terminal is to compress the Source such that the bit rate delivered to the network connection between the Source Terminal and the Destination Terminal is at least approximately appropriate. Other factors may be considered bythe Source Terminal as well. For example, the Source Terminal may be a battery-power-limited device or maybeaware that the Destination Terminalis limited in signal processing power or display capability.

Further, the Source Terminal may packetize the data in a special way to guard against packet loss and aid error concealment at the Destination Terminal. All such factors impinge on the design of the Source Terminal. The Access Network may be reasonably modeled by a single line connection, such as a 28.8 Kbit/s modem, a 56 Kbit/smodem,a1.5Mbit/sAsymmetricDigitalSubscriberLine(ADSL)line,andso on,oritmayactuallybeanetworkthathassharedcapacity,andhencehavepacket loss and delay characteristics in addition to certain rate constraints. The Backbone Networkmayconsistofaphysicalcircuitswitchedconnection,adedicatedvirtual path through a packet-switched network, or a standard best-effort TransmissionControl Protocol/Internet Protocol (TCP/IP) connection, among other possibilities. Thus, this network has characteristics such as bandwidth, latency, jitter, and packetloss,and may or may not have the possibility ofQuality of Service (QoS)guarantees. The Delivery Network may have the same general set of characteristics as the Access Network, or one may envision that in a one-to-many transmission that the Delivery Network might be a corporate intranet.

Finally, the Destination Terminal may have varying power, mobility, display or audio capabilities.

- ―Multimedia‖ indicate that the information/data being transferred over the networkmaybecomposedofoneormoreofthefollowingmediatypes:
  - Text
  - Images
  - Audio
  - video

- Mediatypes
  - Text:unformattedtext,formattedtext
  - Images:computer-generated,pictures
  - Audio:speech,music,generalaudio
  - Video:videoclips,movies,films
- Networktypes
- Multimedia + Network →multimediacommunications

Multimedia Information Representation

- Text,images
  - Blocksofdigitaldata
  - Doesnotvarywithtime(time-independent)
  - Audio,video
  - Varywithtime(time-dependent)
  - Analogsignal
  - Mustbeconvertedintodigitalformforintegration
- Communicationnetworkscannotsupportthehighbitratesofaudio,video →Compressionisappliedtodigitizedsignals.

**MultimediaNetworks:**

Many applications, such as video mail, video conferencing, and collaborative work systems,requirenetworkedmultimedia.Intheseapplications,themultimedia objects are stored at a server and played back at the client‘s sites. Such applications mightrequirebroadcastingmultimediadatatovariousremotelocationsoraccessing large depositories of multimedia sources. Multimedia networks require a very high transferrateorbandwidth,evenwhenthedataiscompressed.Traditionalnetworks areusedtoprovideerror-freetransmission.However,mostmultimediaapplications can tolerate errors in transmission due to corruption or packet loss without retransmissionorcorrection.Insomecases,tomeetreal-timedeliveryrequirements ortoachievesynchronization,somepackets areevendiscarded.Asaresult,wecan applylightweighttransmissionprotocolstomultimedianetworks.Theseprotocols cannotacceptretransmission,sincethatmightintroduceunacceptabledelays.

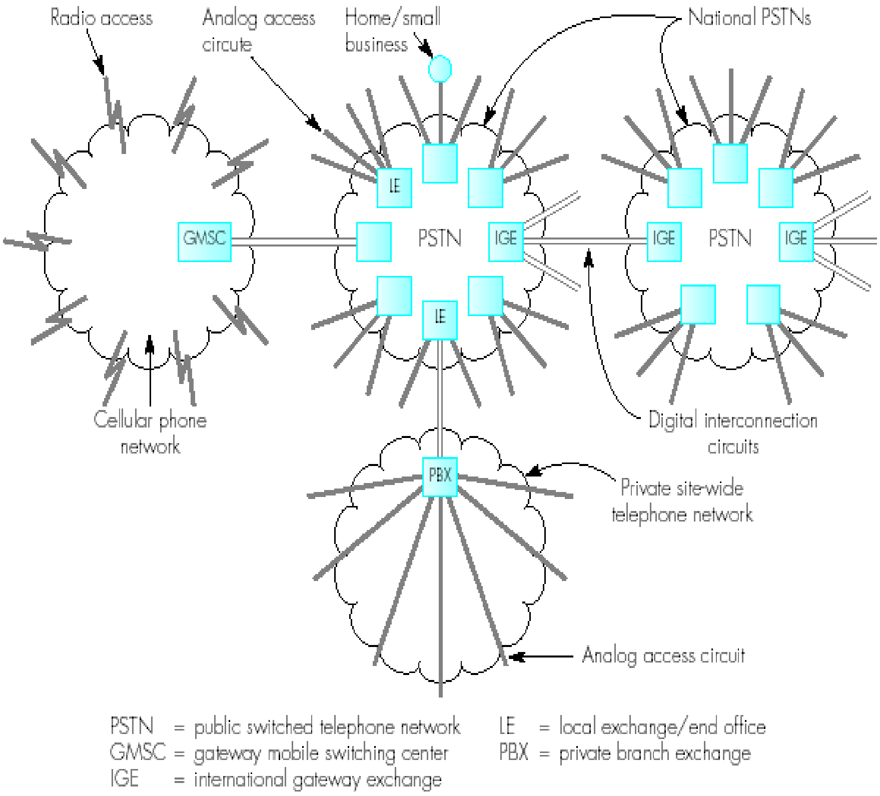
Multimedia networks must provide the low latency required for interactive operation. Since multimedia data must be synchronized when it arrives at the destinationsite,networksshouldprovidesynchronizedtransmissionwithlowjitter. In multimedia networks, most communications are multipoint as opposed to traditionalpoint-to-pointcommunication. For example, conferences involvingmore than two participants need to distribute information in different media to each participant.

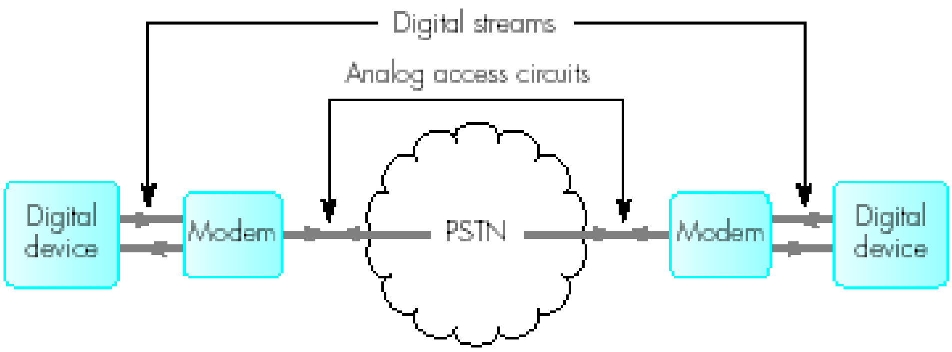
Conference networks use multicasting and bridging distribution methods. Multicasting replicates a single input signal and delivers it to multiple destinations. Bridging combines multiple input signals into one or more output signals, which then deliver to the participants.

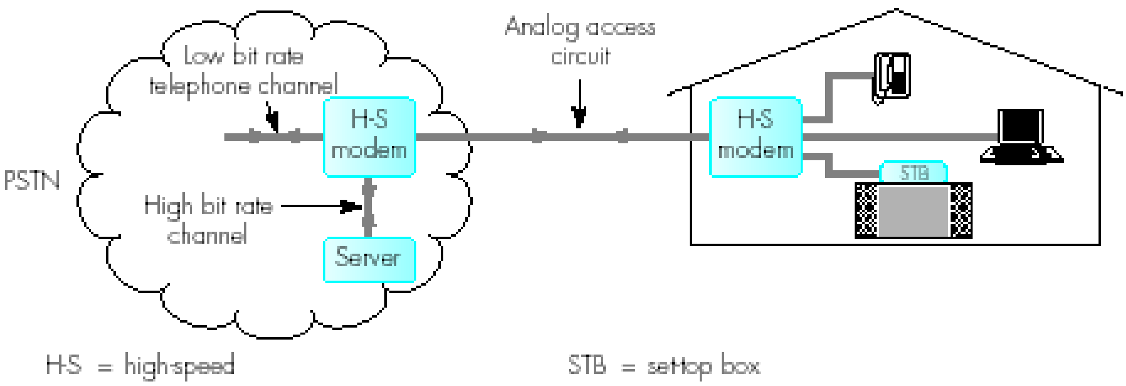
TraditionalnetworksdonotsuitmultimediaEthernet,whichprovidesonly 10 Mbps, its access time is not bounded, and its latency and jitter are unpredictable. Token-ringnetworksprovide16Mbpsandaredeterministic.Fromthispointof view,theycanhandlemultimedia.However,thepredictableworstcaseaccess latency can be very high.

A fiber distributed data interface (FDDI) network provides 100 Mb/s bandwidth, sufficient for multimedia. In the synchronized mode, FDDI has a low access latency and low jitter. It also guarantees a bounded access delay and a predictable average bandwidth for synchronous traffic. However, due to the high cost, FDDI networks are used primarily for backbone networks, rather than networks of workstations.

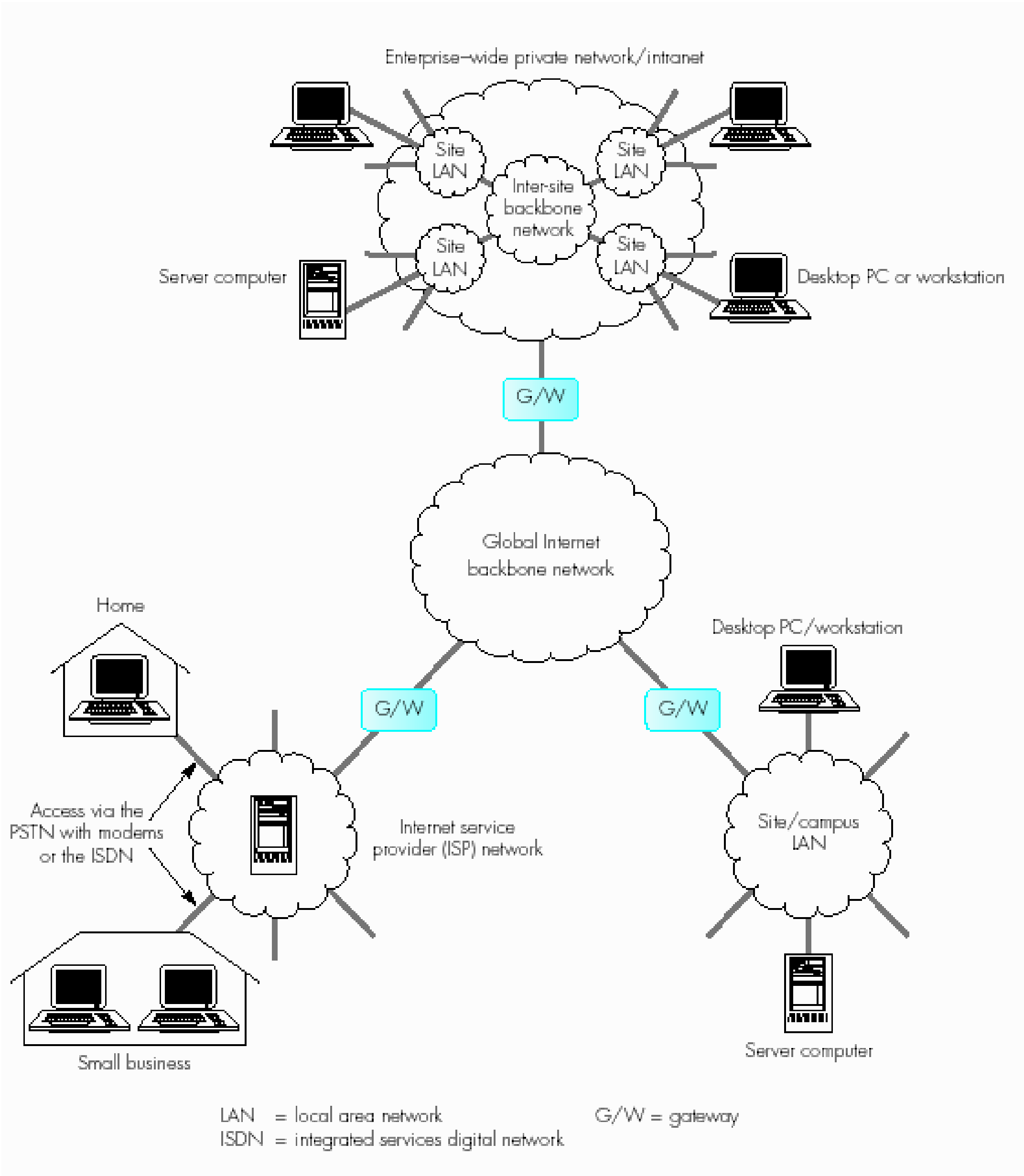
- **Telephonenetworks**



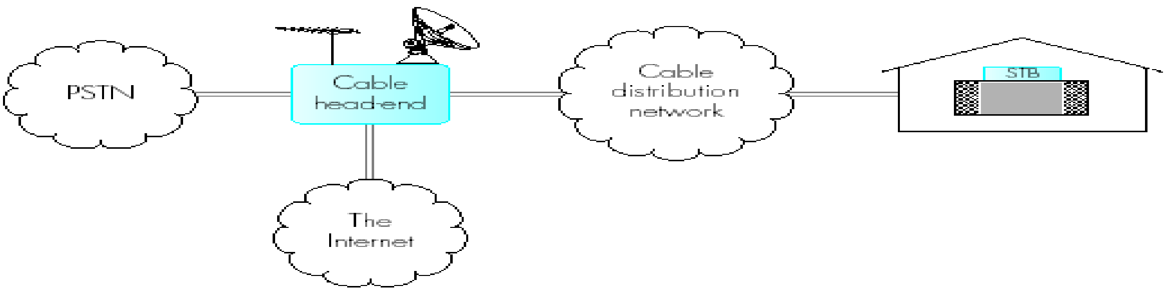



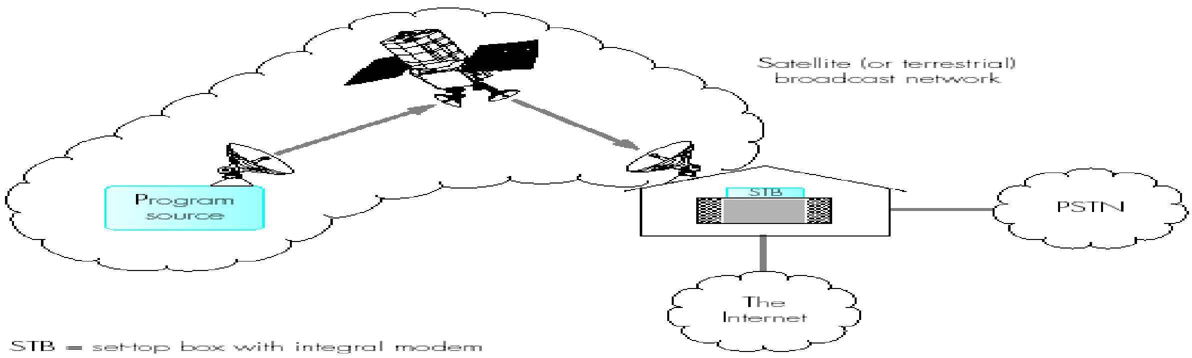



- **Datanetworks:**

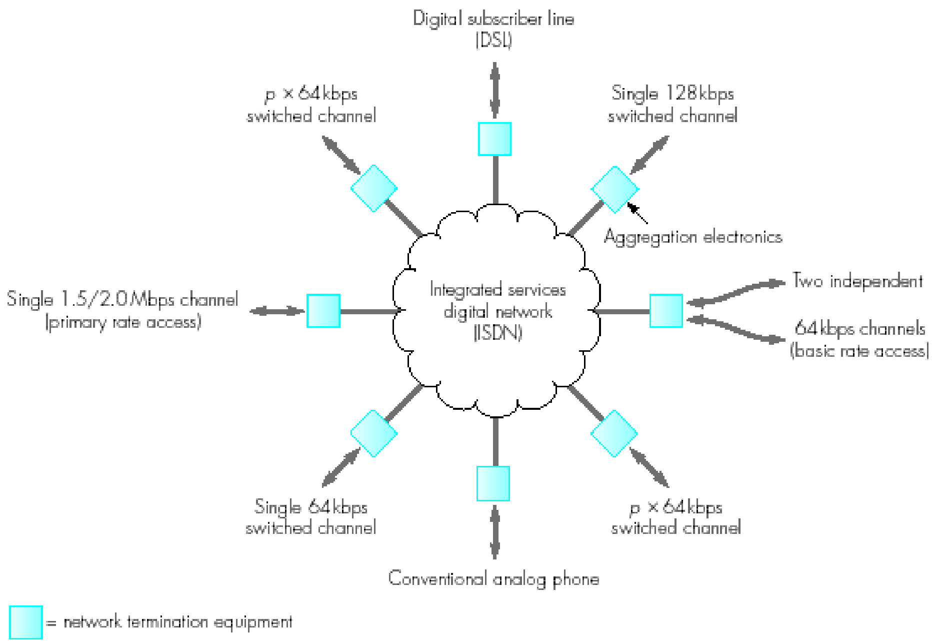



- **Broadcasttelevisionnetworks**

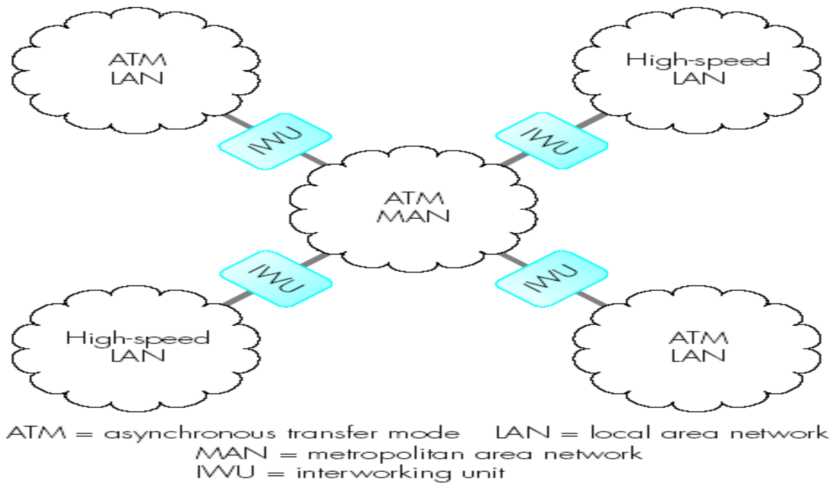




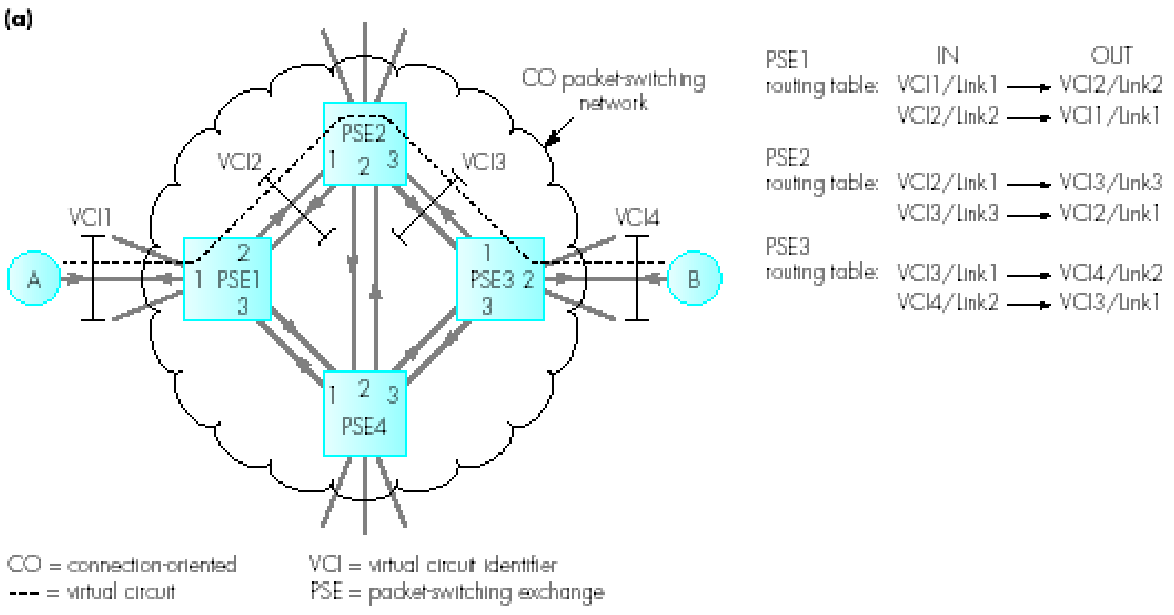

- **Integratedservicesdigitalnetworks**




- **Broadcastmultiservicenetworks**

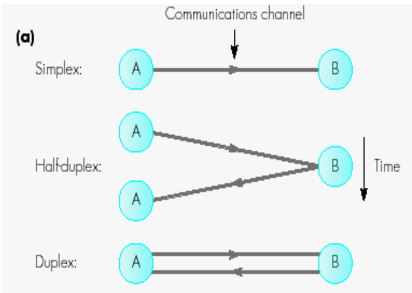


## COpacketswitchednetworkincludingroutingtable:




## Communicationmodes:

(a) unicast



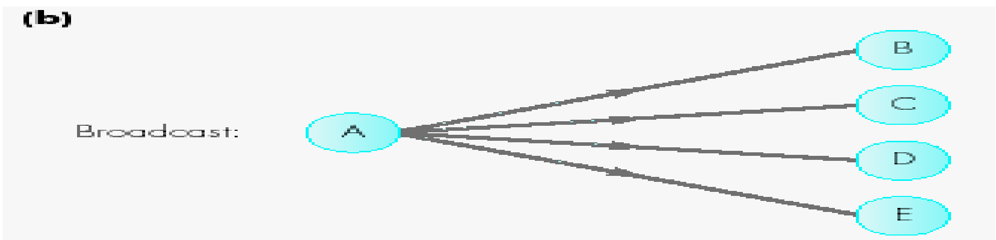

- Simplex:

Information flowsin onedirection onlyEx) transmission of images from deep space probe

- Half-duplex:two-way alternateInformationflows inbothdirectionsbut alternatively Ex) remote server

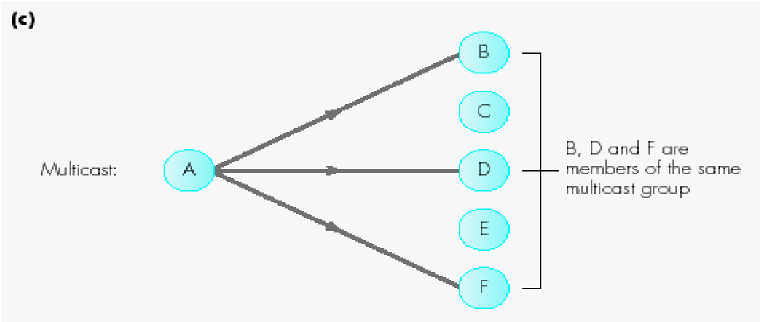
- Duplex: two-way simultaneous Information flows in both directions simultaneously Ex) video telephony

(b) Broadcast:



Informationoutputbyasinglesourceisreceivedbyallothernodes.Ex)cable program over cable network.

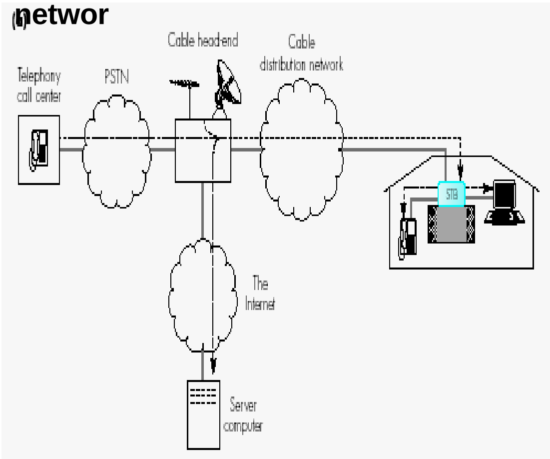
**c)Multicast:Informationoutputbysourceisreceivedbyspecificnodes multicast group Ex) video conferencing**

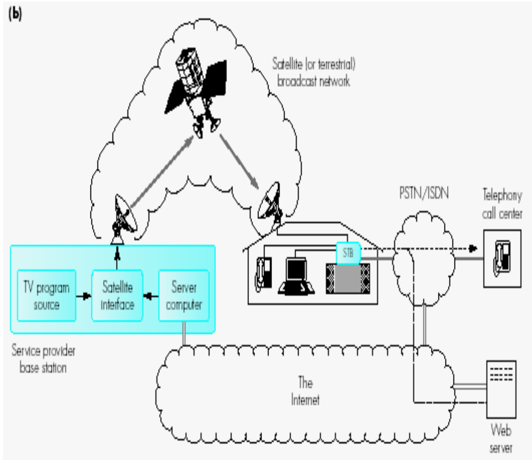


# Interactivetelevision:

**(a) cabledistributionnetwork** **(b) satellite/terrestrial broadcast**

**networ**

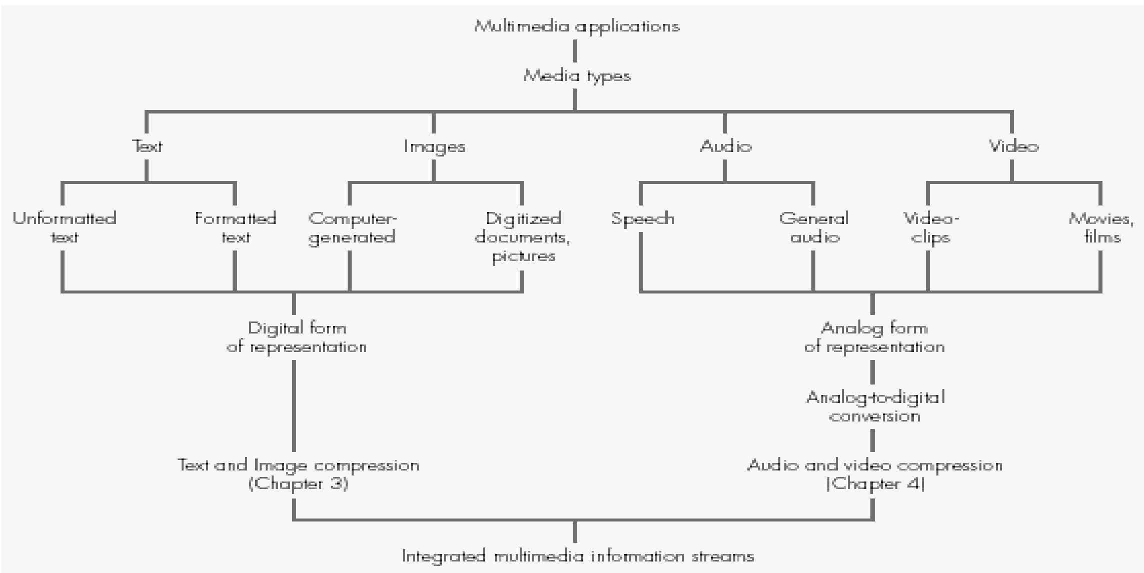


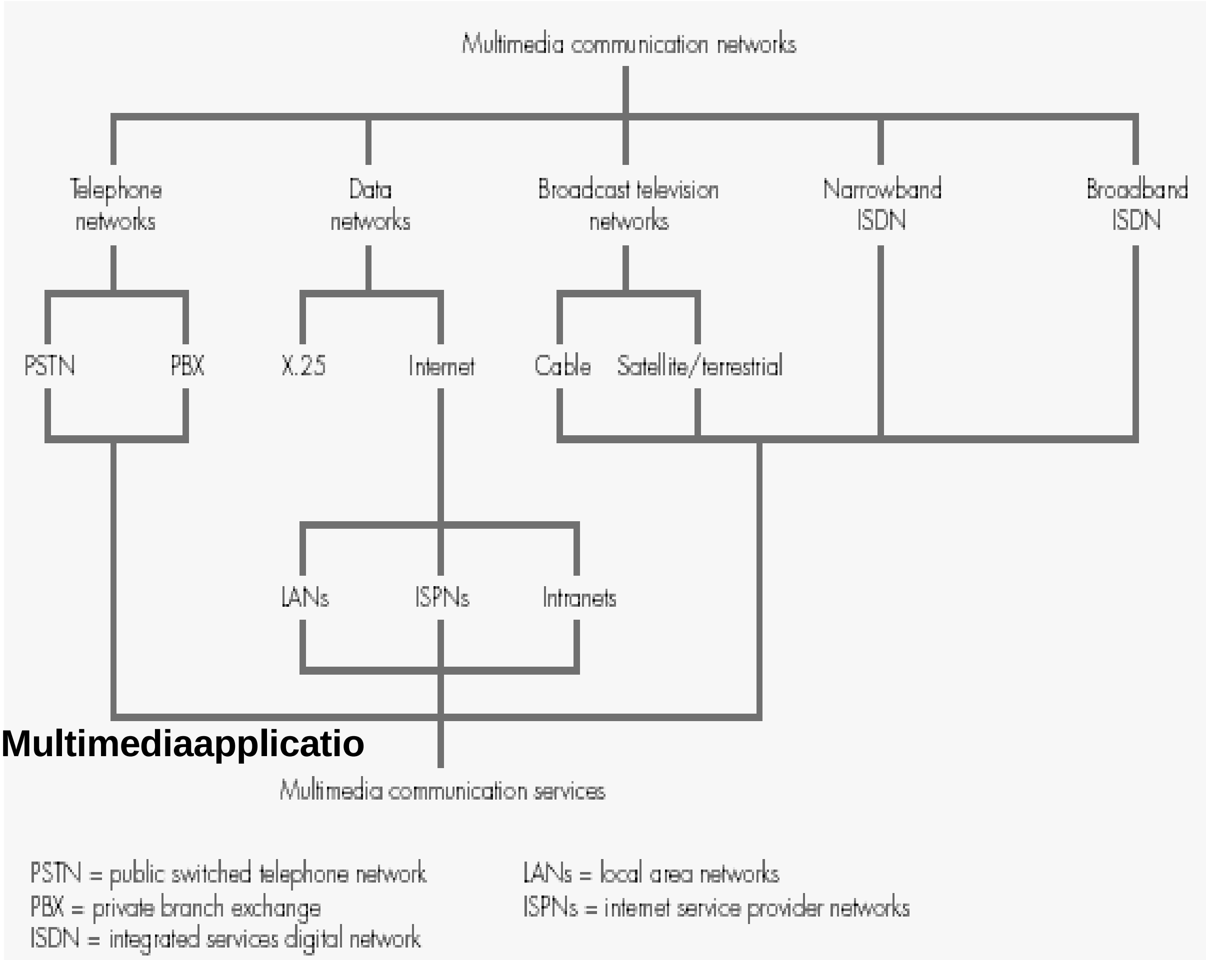

Cablenetwork

- STB provides both low bit rate connection to PSTN and high bit rate connection to Internet
- Subscriberisabletoactivelyrespondtotheinformationbeing broadcast through PSTN
- Typicalreturnchanneluse:voting,game,homeshopping
- Satelliteandterrestrialbroadcastnetworks
- STBprovidessimilarservice

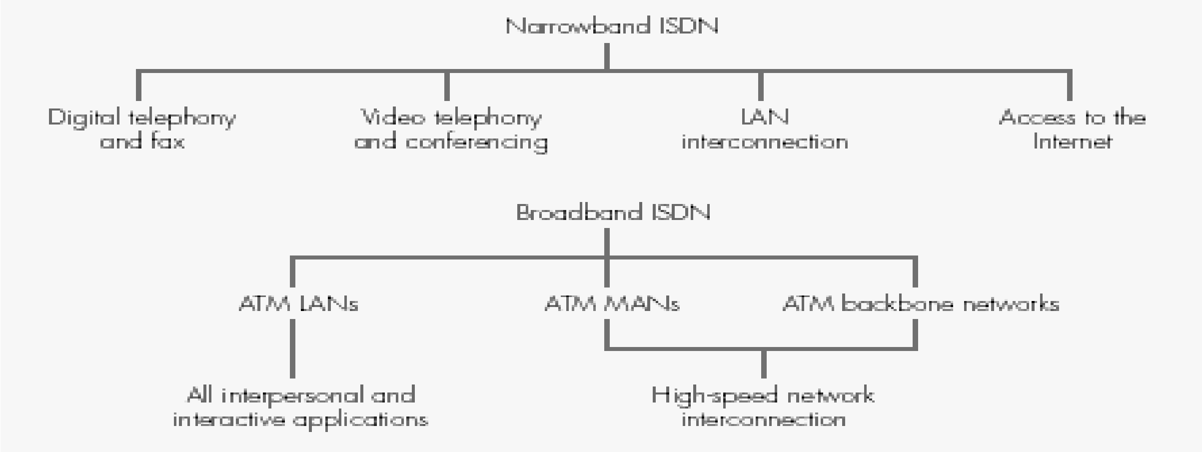
## MediaTypes



# NetworkTypes




# Multimediaapplicatio



## Recommendedquestions:

1. DefineMutimedia.?[02]
2. ListsomeofMultimediaapplications.[05]
3. Listthemultimediacommunicationnetworks.[05]
4. StateNyquist samplingtheorem&Nyquistrate.[05]
5. WhatdoyoumeanbyHypertext?[04]
6. Whatiscompression?[03]
7. Comparelossy&losslesscompression.[07]
8. State & explain the basic form of representation of:Text, Image,Audio,Video?[10]
9. Explainthemeaningofbpsinrelationtodigitizedaudio&video.[05]
10. Explainthemeaningofcompression&whyitisused?[08]
11. ExplainthemeaningofPOTS,localexchangeoffice,PBX,mobileswitching centre, international gateway exchange.[08]
12. Explainwhy most datanetworks operatein a packetmode. Henceexplain whyservicesinvolvingaudioandvideoaresupported?[10]
13. Explain ―Broadband‖ in relation to B-ISDN and why deployment has beendelayed?[08]
14. Describetheprincipaloperationofafaxmachine&whymodemsare required. What is the meaning of PC fax?[10]
15. With aidofblockdiagram explainCSCW?[10]
16. ExplainaWebserver,abrowser,WWW?[05]
17. Explainwebpage,homepage,hyperlink,URL,HTML?[10]

# Module 2:Information Representation

Introduction

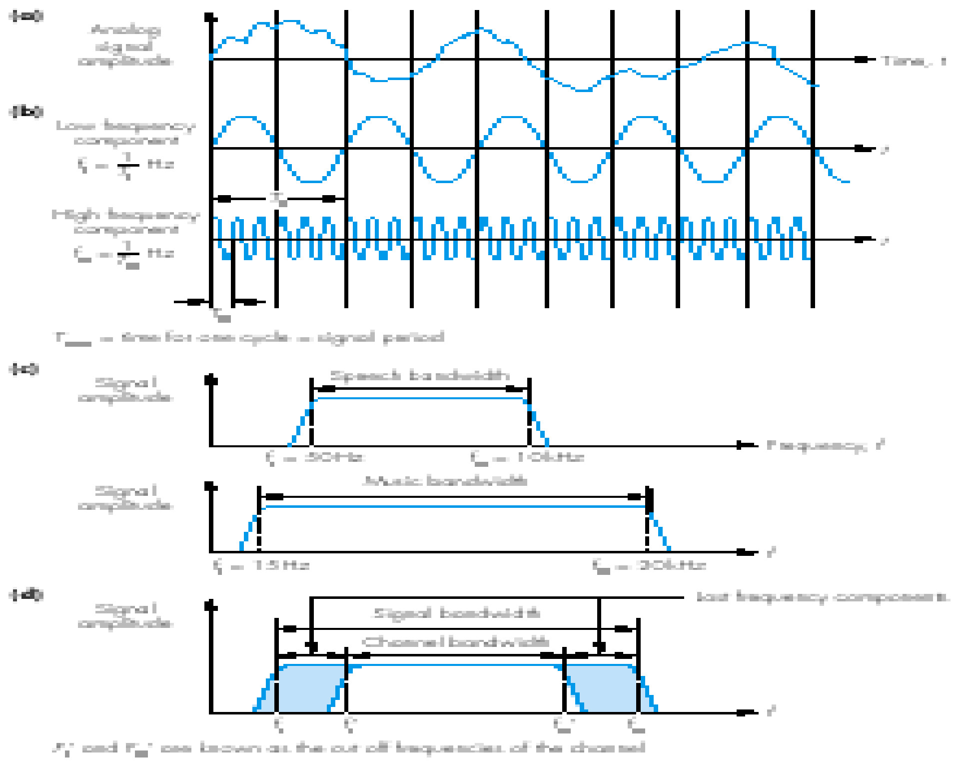
- Theconversionofananalogsignalintoadigitalform
- Signalencoder,sampling, signaldecoder

Digitization principles

Analogsignals

- Fourier analysis can be used to show that any time-varying analog signal is made up of a possibly infinite number of single-frequency sinusoidal signals whose amplitude and phase vary continuously with time relative to each other
- Signalbandwidth
- Fig2.1
- The bandwidth of the transmission channel should be equal to or greater than thebandwidthofthesignal—bandlimitingchannel

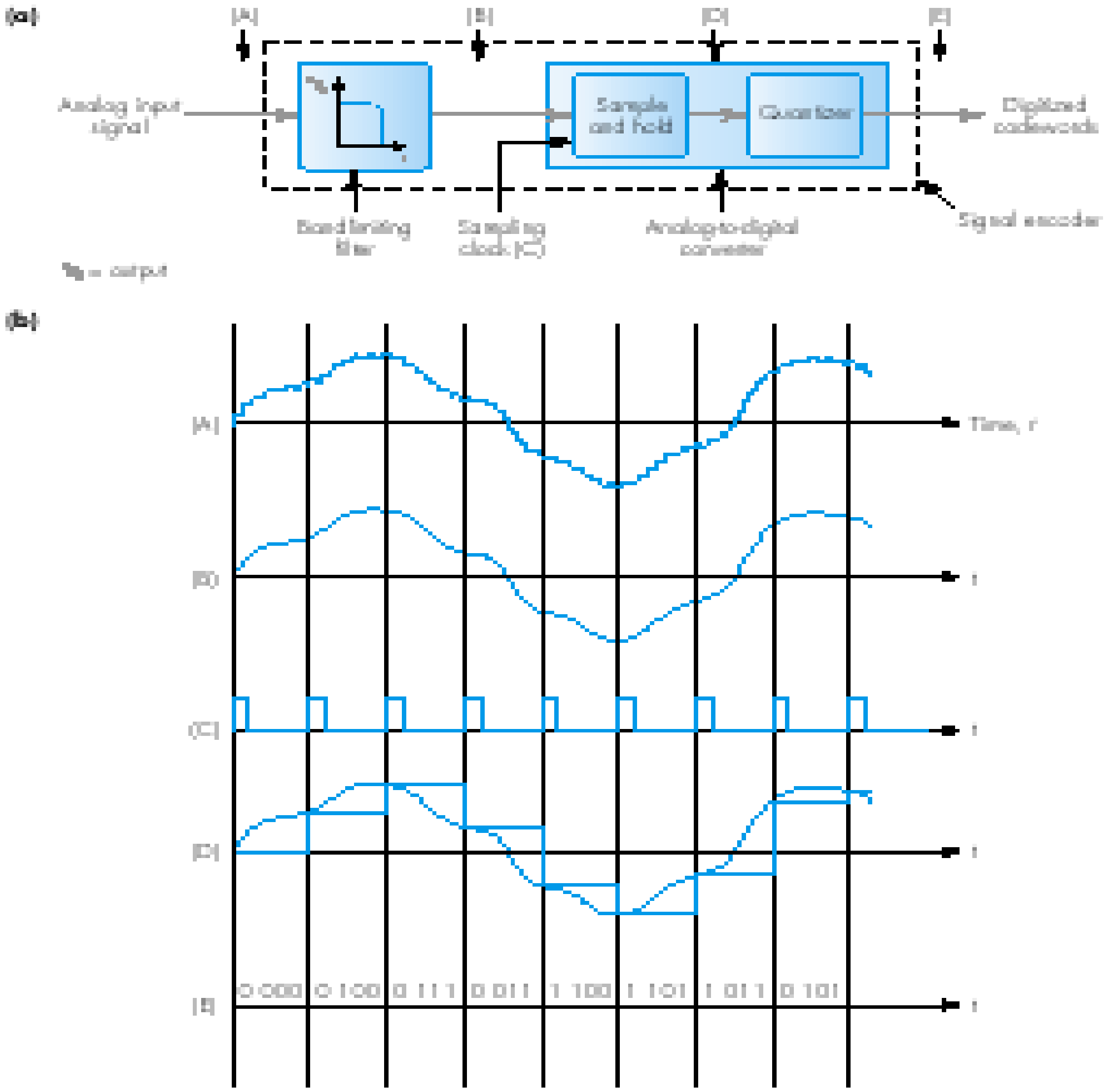
Figure 2.1 Signal properties: (a) time-varying analog signal; (b) sinusoidial frequency components; (c) signal bandwidth examples; (d) effect of a limited bandwidth transmission channel.



Encoderdesign

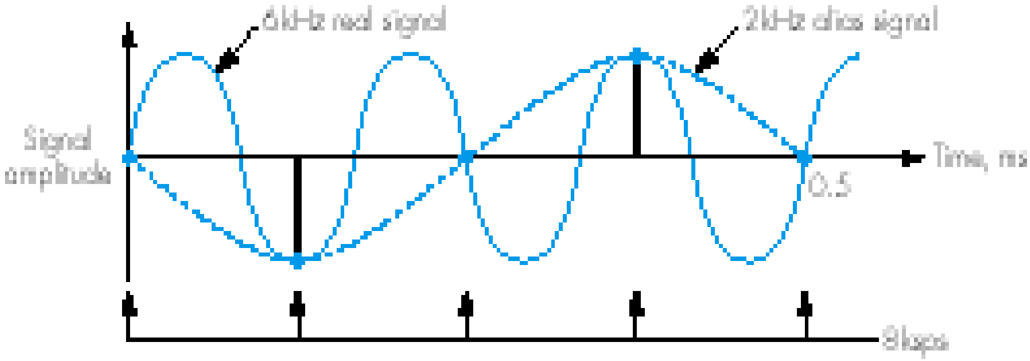
- Abandlimitingfilterandananalog-to-digitalconverter(ADC),thelattercomprising a sample-and-hold and a quantizer
- Fig2.2
- Removeselectedhigher-frequencycomponentsfromthesourcesignal(A)
- (B)isthenfedtothesample-and-holdcircuit
- Sampletheamplitudeofthefilteredsignalatregulartimeintervals(C)and holdthesample amplitudeconstant between samples(D)

**Figure 2.2 Signal encoder design: (a) circuit components; (b) associated waveform set.**



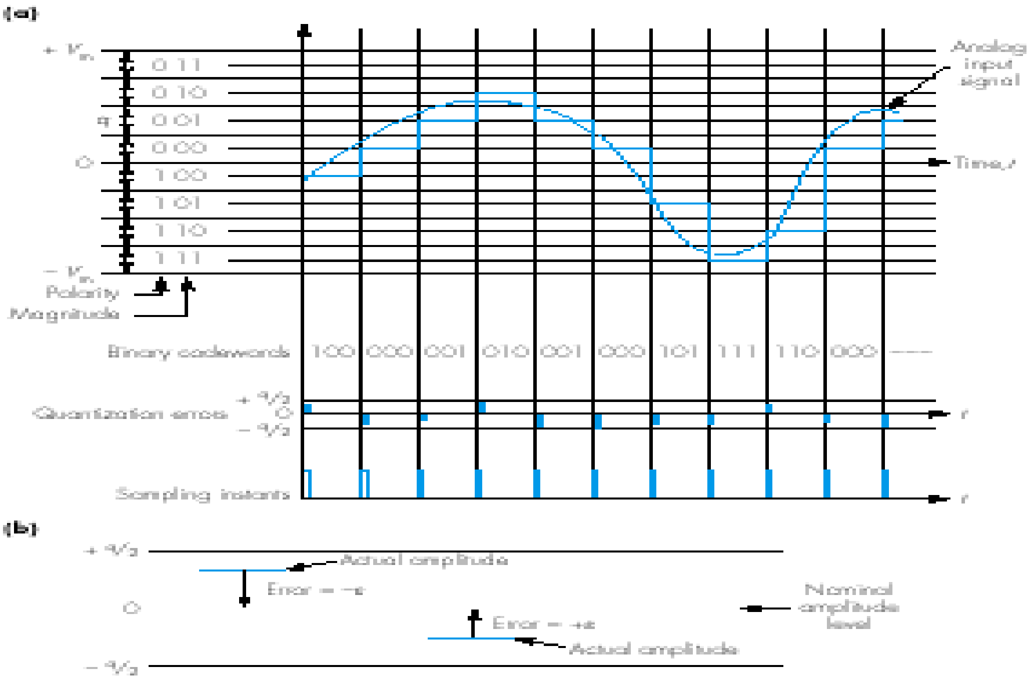
- Quantizercircuit which converts each sample amplitude into a binaryvalue known as a codeword (E)
- The signal to be sampled at a rate which is higher than the maximum rate of change of the signal amplitude
- Thenumberofdifferentquantizationlevelsusedtobeaslargeaspossible
- Nyquist sampling theorem states that: in order to obtain an accurate representationofatime-varinganalogsignal,itsamplitudemustbesampled at a minimum rate that is equal to or greater than twice the highest sinusoidal frequency component that is present in the signal
- Nyquistrate:samplespersecond(sps)
- ThedistortioncausedbysamplingasignalataratelowerthantheNyquist rate
- Fig2.3
- Aliassignals:theyreplacethecorrespondingoriginalsignals

**Figure2.3Aliassignalgenerationduetoundersampling.**




- Quantizationintervals
- A finite number of digits is used, each sample can only be represented by a corresponding number of discrete levels
- Fig2.4
- If Vmax is the maximum positive and negative signal amplitude and n is the numberofbinarybitsused,thenthemagnitudeofeachquantizationinterval, q

Figure 2.4 Quantization procedure: (a) source of errors; (b) noise polarity.




- Eachcodewordcorrespondstoanominalamplitudelevelwhichisatthe center of the corresponding quantization interval
- Thedifferencebetweentheactualsignalamplitudeandthecorresponding nominalamplitudeiscalledthequantizationerror(Quantizationnoise)
- Theratioofthepeakamplitudeofasignaltoitsminimumamplitudeisknown as the dynamic range of the signal, $D$ (decibels or dB)

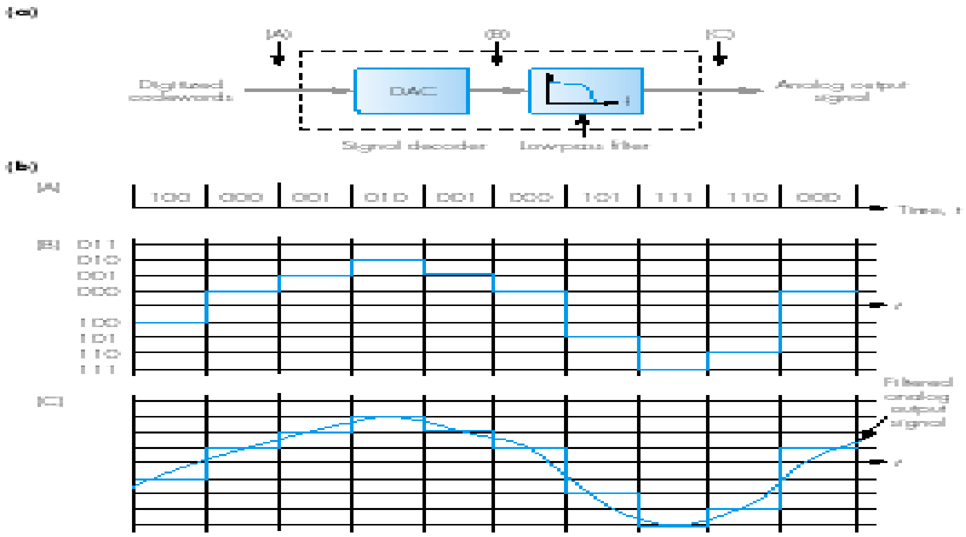
$$D = 20\log_{10}\left(\frac{V_{max}}{V_{min}}\right) dB$$

- It is necessary to ensure that the level of quantization noise relative to the smallest signal amplitude is acceptable
- Example2.2

## Decoderdesign

- Fig2.5
- Reproduce the original signal, the output of the DAC is passed through a low-pass filter which only passes those frequency components that made up the original filtered signal (C)
- Audio/videoencoder-decoderor audio/videocodec

**Figure 2.5 Signal decoder design: (a) circuit components; (b) associated waveform set.**



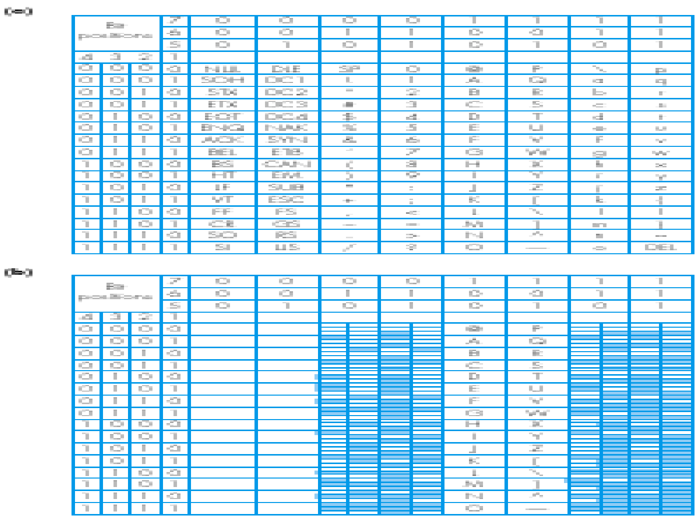

## Text

- Threetypesoftext
  - Unformattedtext
  - Formattedtext
  - hypertext

Unformattedtext

- AmericanStandardCodeforInformationInterchange(ASCIIcharacterset)
- Fig2.6
- Mosaiccharacterscreaterelativelysimplegraphicalimages

**Figure 2.6 Two example character sets to produce unformatted text: (a) the basic ASCII character set; (b) supplementary set of mosaic characters.**



Formattedtext

- Producedbymostwordprocessingpackages
- Each with different headings and with tables, graphics, and pictures inserted at appropriate points
- Fig2.8
- WYSIWYG:anacronymforwhat-you-see-is-what-you-get

**Figure2.8 Formatted text:(a) anexampleformattedtextstring;(b) printed version of the string.**

(a)

```
<B><FONT SIZE=4><P>Formatted Text</P>
</B></FONT>
<P>This is an example of formatted text, it includes:</P>
<FONT SIZE=2>
</FONT><I><P>Italics,</I> <B>Bold</B> and <U>Underlining</P>
</U>
<FONT FACE="French Script MT"><P>Different Fonts</FONT> and <FONT
SIZE=4>Font Sizes</P>
```

(b)

**Formatted text**

This is an example of formatted text, it includes:

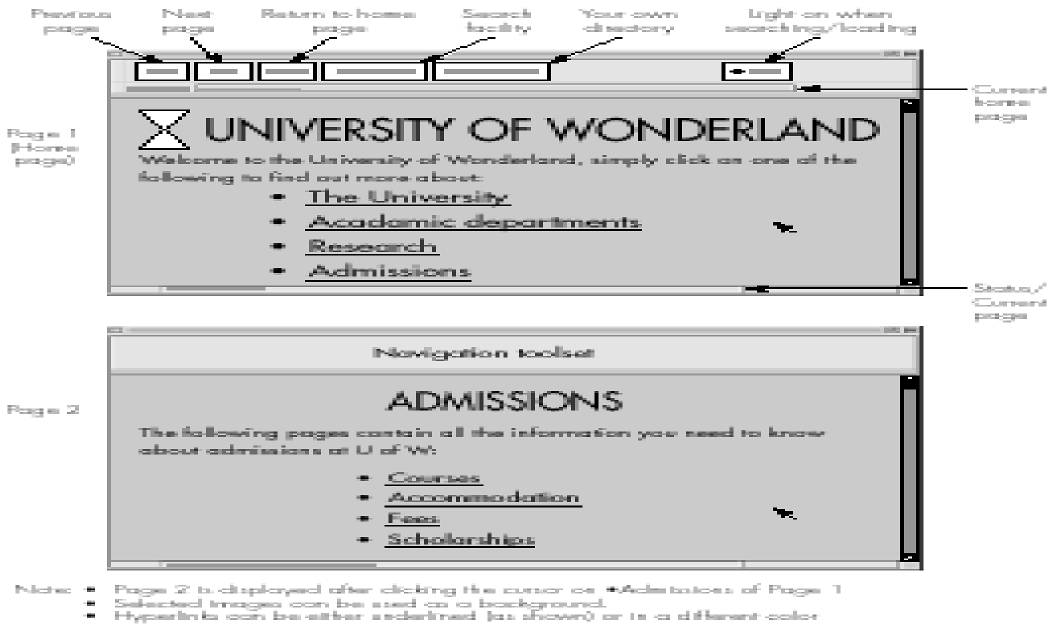
*Italics*, **Bold** and <u>Underlining</u>

Different fonts and Font Sizes

Hypertext

- Formattedtextthatenablesarelatedsetofdocuments—normallyreferredto as pages—to be created which have defined linkage points—referred to as hyperlinks —between each other
- Fig2.9

**Figure 2.9 Example of an electronic document written in hypertext.**



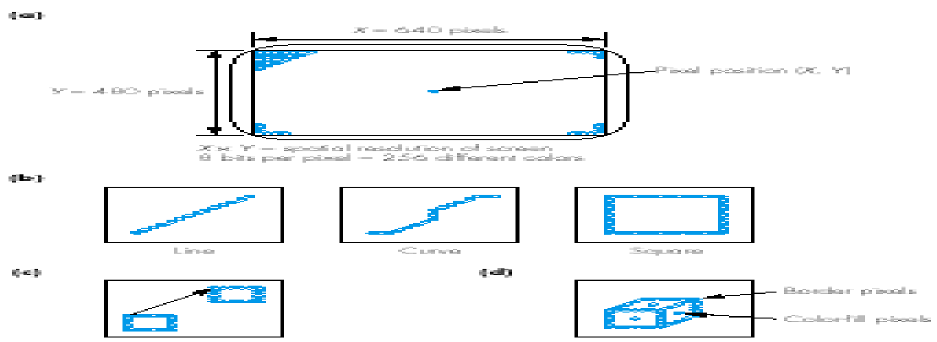
Images

- Image are displayed in the form of a two-dimensional matrix of individual picture elements—known as pixels or pels

Graphics

- Fig2.10
- Twoformsofrepresentationofacomputergraphic:ahigh-levelversion (similartothesourcecodeofahigh-levelprogram)andtheactualpixel- image of the graphic (similar to the byte-string corresponding to the low-level machine code—bit-map format)
- Standardized forms of representation such as GIF (graphical interchange format) and TIFF (tagged image file format)

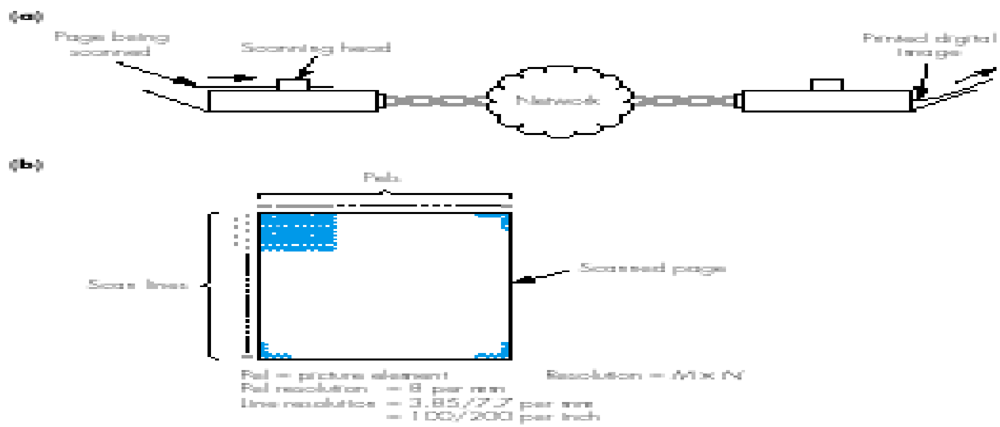
Figure 2.10 Graphics principles: (a) example screen format; (b) some simple object examples; (c) effect of changing position attribute; (d) solid objects.




## Digitizeddocuments

- **Fig2.11**
- **A single binary digit to represent each pel, a 0 for a white pel and a 1 for a black pel**

Figure 2.11 Facsimile machine principles: (a) schematic; (b) digitization format.



Digitizedpictures

- Colorprinciples
- Awhole spectrumofcolors─known asacolorgamut─can beproducedby using different proportions of red(R), green(G), and blue (B)
- Fig2.12
- Additive colormixingproducingacolorimage onablacksurface
- Subtractivecolormixingforproducingacolorimageonawhitesurface
- Fig2.13

**Figure 2.12 Color derivation principles: (a) additive color mixing; (b) subtractive color mixing.**

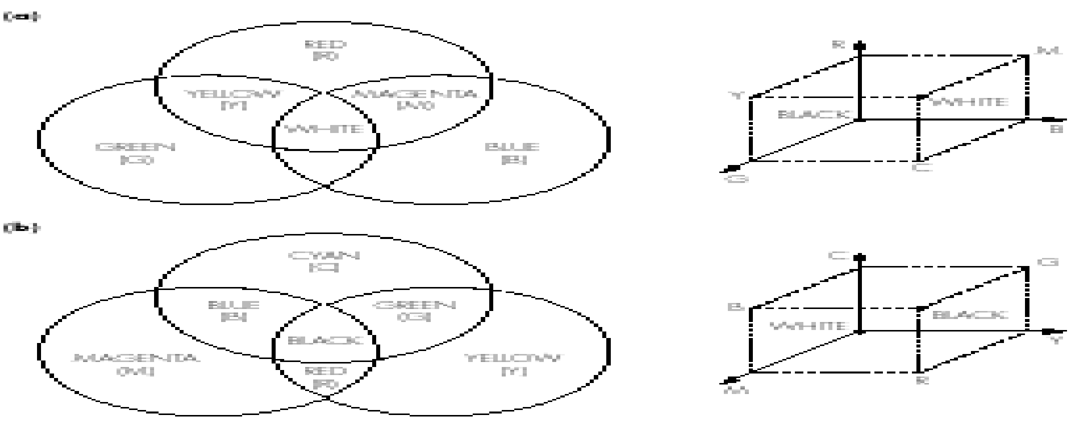
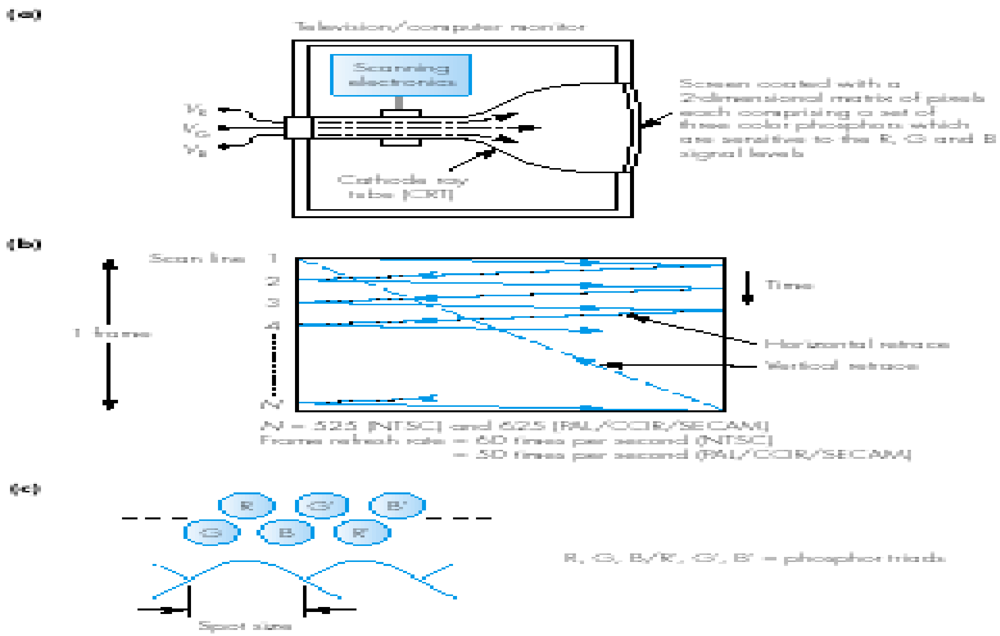



**Figure 2.13 Television/computer monitor principles: (a) schematic; (b) raster-scan principles; (c) pixel format on each scan line.**




2.4.3Digitizedpictures

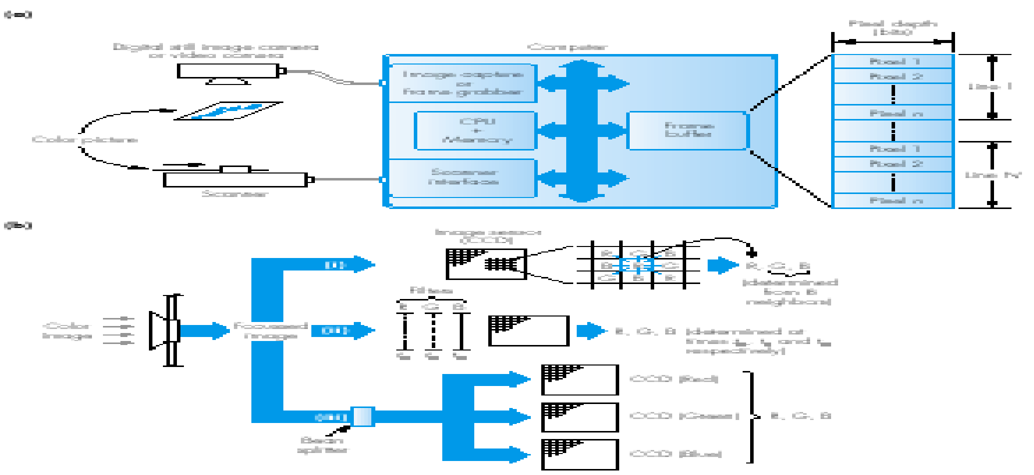
- Raster-scanprinciples
- Progressivescanning
- Eachcompletesetofhorizontalscaniscalledaframe
- Thenumberofbitsperpixelisknownasthepixeldepthanddeterminesthe range of different colors
- Aspectratio
- Boththenumberofpixelsperscannedlineandthenumberoflinesperframe
- Theratioofthescreenwidthtothescreenheight
- National Television Standards Committee (NTSC), PAL(UK), CCIR(Germany), SECAM (France)
- Table2.1

**Table 2.1 Example display resolutions and memory requirements.**

| Standard | Resolution | Number of colors | Memory required per frame (bytes) |
|---|---|---|---|
| VGA | 640 × 480 × 8 | 256 | 307.2 kB |
| XGA | 640 × 480 × 16<br>1024 × 768 × 8 | 64 K<br>256 | 614.4 kB<br>786.432 kB |
| SVGA | 800 × 600 × 16<br>1024 × 768 × 8<br>1024 × 768 × 24 | 64 k<br>256<br>16 M | 960 kB<br>786.432 kB<br>2359.296 kB |

- Digitalcamerasandscanners
- Animageiscapturedwithinthecamera/scannerusinganimagesensor
- Atwo-dimensionalgridoflight-sensitivecellscalledphotosites
- Awidely-usedimagesensorisacharge-coupleddevice(CCD)
- Fig2.16

**Figure 2.16 Color image capture: (a) schematic; (b) RGB signal generation alternatives.**



## 2.4.3Digitizedpictures

- Raster-scanprinciples
- Progressivescanning
- Eachcompletesetofhorizontalscaniscalledaframe
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- Fig2.16

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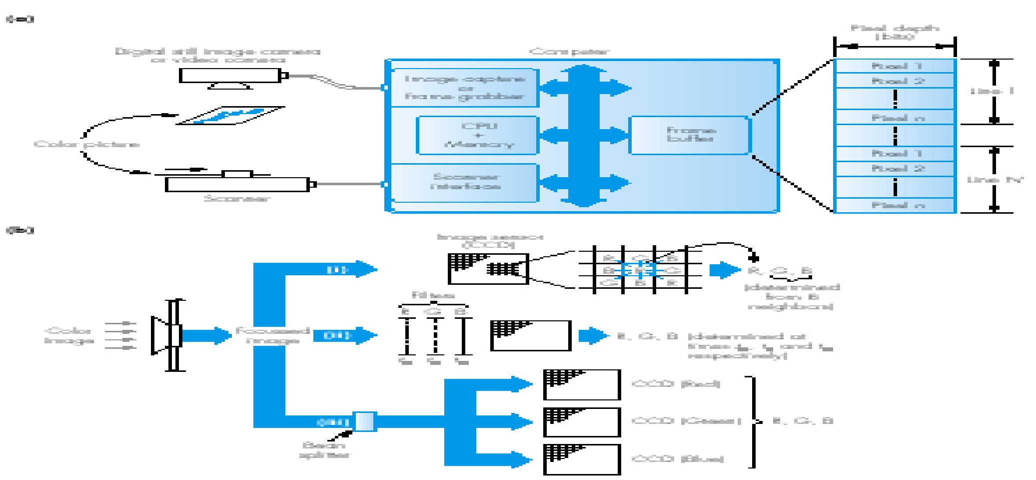


## Audio

- Thebandwidthofatypicalspeechsignalisfrom50Hzthroughto10kHz; music signal from 15 Hz through to 20kHz

- Thesamplingrate:20ksps(2*10kHz)forspeechand40ksps(2*20kHz)for music
- Music stereophonic (stereo) results in a bit rate double that of a monaural(mono) signal
- Example2.4

2.5.2 CD-quality audio

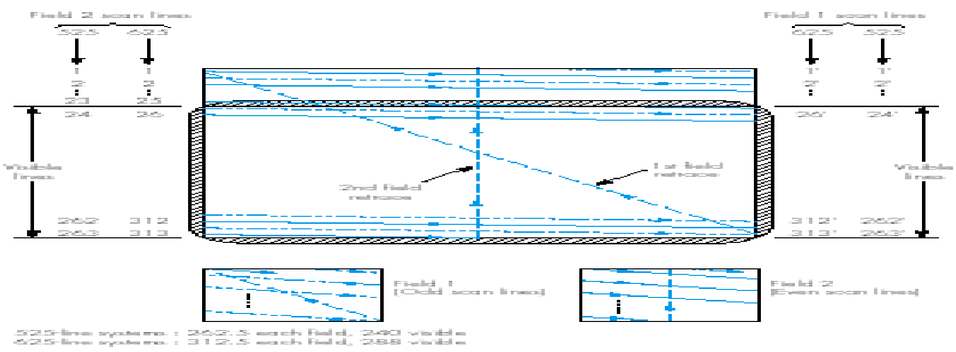
- Bitrateperchannel = samplingrate*bitspersample $= 44.1\times10^3\times16 = 705.6kbps$
- Totalbitrate=2*705.6=1.411Mbps
- Example2.5

Video

Broadcasttelevision

- Scanningsequence
- Itisnecessarytouseaminimumrefreshrateof50timespersecondtoavoid flicker
- Arefreshrateof25timespersecondissufficient
- Field:thefirstcomprisingonlytheoddscanlinesandthesecondtheeven scan lines
- Thetwofieldarethenintegratedtogetherinthetelevisionreceiverusinga technique known as interlaced scanning
- Fig2.19
- Thethreemainpropertiesofacolorsource
  - Brightness
  - Hue:thisrepresentstheactualcolorofthesource
  - Saturation:thisrepresentsthestrengthorvividnessofthecolor

Figure 2.19 Interlaced scanning principles.



- Thetermluminanceisusedtorefertothebrightnessofasource
- Thehueandsaturationarereferredtoasitschrominance

$$Y_s=0.299R_s+0.587G_s+0.144B_s$$

- Where Ys is the amplitude of the luminance signal and Rs,Gs and Bs are themagnitudes of the three color component signals

- Thebluechrominance(Cb),andtheredchrominance(Cr)arethenusedto represent hue and saturation
- Thetwocolordifferencesignals:

$$C_b=B_s-Y_s \qquad C_r=R_s-Y_s$$

- InthePALsystem,CbandCrarereferredtoas*U*and*V*respectively

$$PAL:Y=0.299R+0.587G+0.114B \quad U=0.493(B-Y)$$

$$V=0.877(R-Y)$$

- TheNTSCsystemformtwodifferentsignalsreferredtoas*I*and*Q*

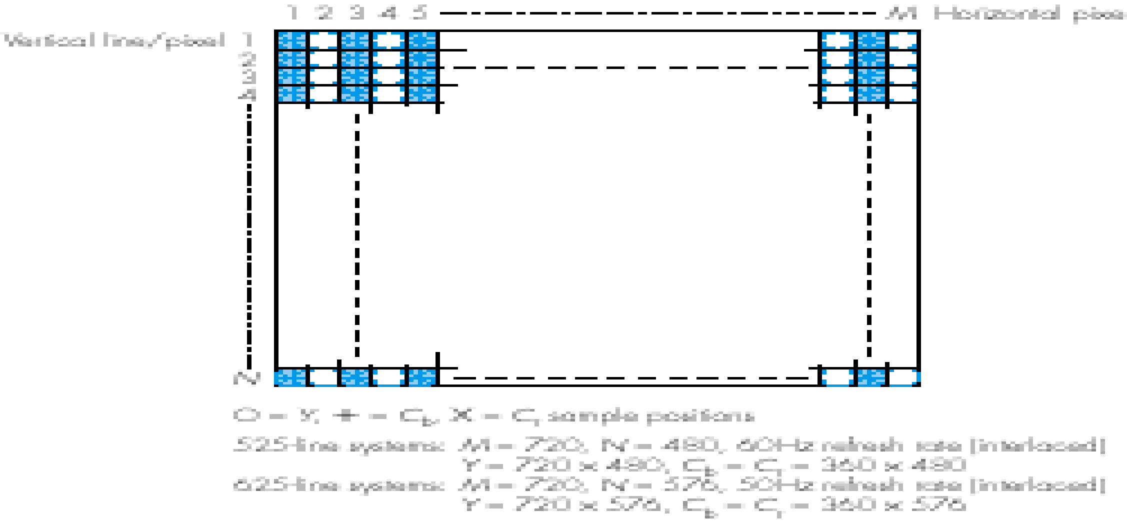
$$NTSC:Y=0.299R+0.587G+0.114B \quad I=0.74(R-Y)-0.27(B-Y)$$

$$Q=0.48(R-Y)+0.41(B-Y)$$

Digitalvideo

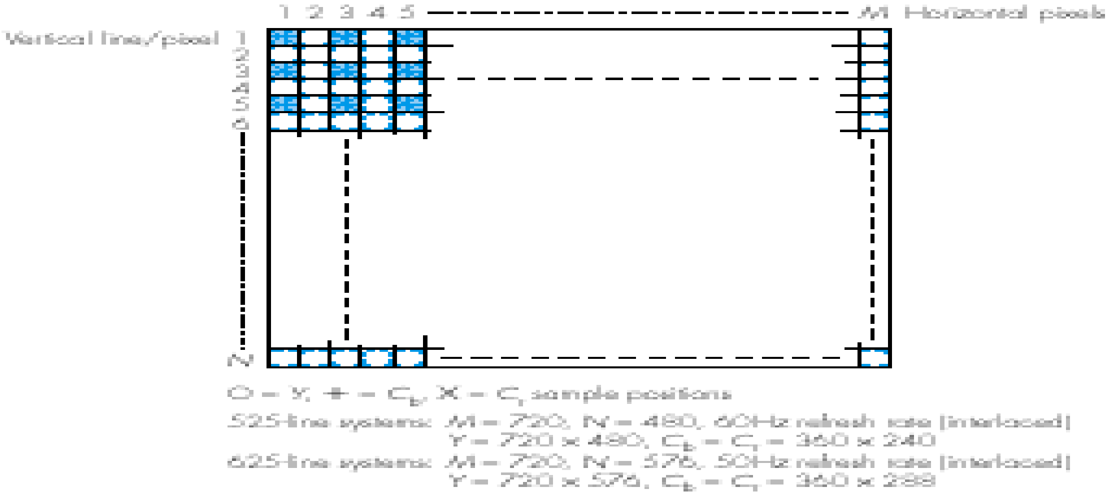
- Eyehaveshownthattheresolutionoftheeyeislesssensitiveforcolorthanit is for luminance
- 4：2：2format
- TheoriginaldigitizationformatusedinRecommendationCCIR-601
- Alinesamplingrateof13.5MHzforluminanceand6.75MHzforthetwo chrominance signals
- Thenumberofsamplesperlineisincreasedto720
- Thecorrespondingnumberofsamplesforeachofthetwochrominance signals is 360 samples per active line
- Thisresultsin4Ysamplesforevery2Cb,and2Crsamples
- Thenumbers480and576beingthenumberofactive(visible)linesinthe respective system
- Fig.2.21
- Example2.7

Figure2.21Samplepositionswith4:2:2digitizationformat.



- 4：2：0formatisusedindigitalvideobroadcastapplications
- Interlacedscanningisusedandtheabsenceofchrominancesamplesinalternative lines
- Thesameluminanceresolutionbuthalfthechrominanceresolution
- Fig2.22

Figure2.22Samplepositionsin4:2:0digitizationformat.



525-linesystem

$Y=720\times480$

$C_b=C_r=360\times240$

625-linesystem

$Y=720\times480$

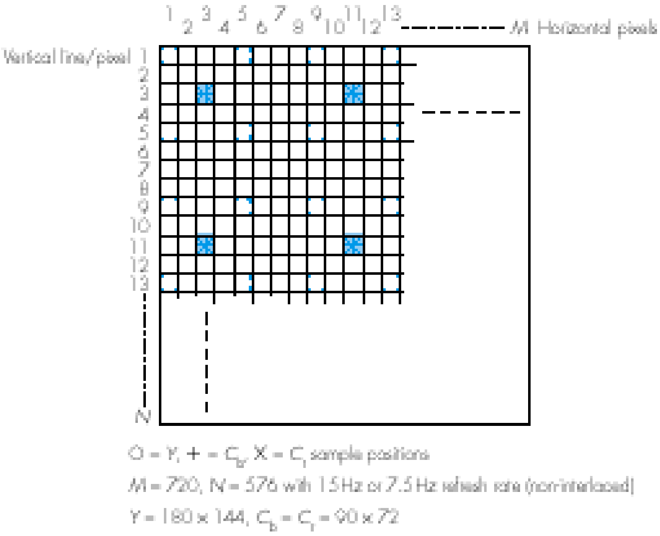
$C_b=C_r=360\times288$

$$13.5\times10^6\times8+2(3.375\times10^6\times8)=162Mbps$$

-  HDTVformats:theresolutiontothenewer16/9wide-screentubescanbeup to 1920*1152 pixels
-  Thesourceintermediateformat(SIF)giveapicturequalitycomparablewith video recorders(VCRs)
-  Thecommonintermediateformat(CIF)foruseinvideoconferencing applications
-  Fig2.23
-  ThequarterCIF(QCIF)foruseinvideotelephony applications
-  **Fig2.24**
-  **Table2.2**

**Figure 2.23 Sample positions**

**for SIF and CIF. Figure 2.24**




video digitization formats.

| System | Spatial resolution | Temporal resolution |
|---|---|---|
| 525-line | $Y = 640 \times 480$ | 60 Hz |
| | $C_b = C_r = 320 \times 240$ | |
| 625-line | $Y = 768 \times 576$ | 50 Hz |
| | $C_b = C_r = 384 \times 288$ | |
| 525-line | $Y = 320 \times 240$ | 30 Hz |
| | $C_b = C_r = 160 \times 240$ | |
| 625-line | $Y = 384 \times 288$ | 25 Hz |
| | $C_b = C_r = 192 \times 144$ | |
| | $Y = 384 \times 288$ | 30 Hz |
| | $C_b = C_r = 192 \times 144$ | |
| | $Y = 192 \times 144$ | 15/7.5 Hz |
| | $C_b = C_r = 96 \times 72$ | |

## RECOMENDDEDQUESTIONS:

1. Expalincodeword,analogsignal,signalencoder,signaldecoder?[06]
2. Define―bandwidth‖?explain―bandlimitingchannel‖?[05]
3. Explainnyquistsamplingtheorem&nyquistrate?[04]
4. Definethemeaningoftermquantizationinterval&howth isinfluencesthe accuracy of the sampling process of an analog signal? [06]
5. Explain a)unformatted/plaintext.
   b) formatted/richtext.
   c) Hypertext. [06]
6. Differentiateformattedtext&unformattedtext?Explaino rigintheacronym WYSIWYG? [05]
7. Explainbriefly:visualobject,freeformobject,clipart,3-Dobjects.[04]
8. Explainscanning,pels,digitizationprincipleswrftofascimilemachines?[0 8]
9. Definetheaspectratioofadisplayscreen.givetwoexamplesfo rcurrentwidely used screen sizes? [05]
10. Derivethe timetotransmitan image with eachtypeofdisplayassuming a bitrate of 56 kbps, 1.5Mbps?[06]
11. Definetext&image.[03]
12. Defineaudio&video.[03]
13. Compareformatted&unformattedtext.[08]
14. Whatisrendering&clipart?[02]
15. Whatisflicker&framerefreshrate?[04]
16. WhatisNTSC&PAL?[10]
17. Whatissample&hold,Quantizer?[06]
18. Defineaspectratio&pixeldepth.[06]